ARKIV FÖR FYSIK Band 3 nr 12

Communicated 14 February 1951 by AXEL E. LINDH

The K-absorption limit of antimony

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The wavelength value of the K-absorption limit of antimony has become of special interest since VON FRIESEN published his new method of studying the energy relations in electron diffraction patterns (1). This fact has motivated a redetermination of the value in question.

The work was carried out in accordance with the Cauchois-method (2). As reference lines were used Te $K\alpha_1 \alpha_2 \beta_1$, the wavelength values of which have been determined by INGELSTAM with the method mentioned above (3). In order to check these relative values an absolute measurement of the $K\alpha_1$-line of antimony was performed. On account of the discrepancy between the different measurements of the Ag $K\alpha_1$-line used by INGELSTAM as a reference line, it seemed of some interest to make an absolute measurement of that value too, although it does not directly influence the determination of the K-edge of antimony.

The emission lines were measured with a tube spectrometer in the usual manner (4). The apparatus used for the absorption measurement has been thoroughly described by INGELSTAM (5). Thus only data and results will be given.

The tube measurements were performed with a calcite crystal in the second order. The length of the tube was 372.21 ± 0.05 mm, and the width of the slit 0.02 mm. The time of exposure was 7 hours for antimony and 5 hours for silver (Ilford Process plates). The current through the X-ray tube was about 5 mA and the applied voltage 60 kV. The results are given in the following table.

Table 1

Notations: t = temperature; $2\varphi_0$ = the angle obtained from reading the angular scale; a = the distance between the $K\alpha_1$-lines of the double exposure; $2\Delta\varphi$ = the angle computed from a and the tube length; $\varphi_t = \varphi_0 + \Delta\varphi$ = the glancing angle at t° C; $\Delta\varphi_t''$ = the temperature correction of the glancing angle; φ_{18} = the glancing angle at 18° C.

	Plate No.	$2\varphi_0$	a mm	$2\Delta\varphi$	φ_t	t	$\Delta\varphi_t$	φ_{18}
Sb	7	18° 9′50″.5	−2.192	−20′14″.7	8°54′47″.9	18°.0	—	8°54′47″.9
	8	17°39′56″.3	+1.050	+ 9′42″.0	49″.2	16°.4	−0″.6	48″.6
						Mean value		8°54′48″.3
Ag	2	21° 8′ 6″.2	+0.6745	+ 6′13″.8	10°37′10″.0	19°.6	+0″.6	10°37′10″.6
	3	29′52″.0	−1.6923	−15′37″.8	7″.1	20°.2	+0″.9	8″.0
						Mean value		10°37′ 9″.3

With Siegbahn's value of the lattice constant of calcite (6) the following results are obtained.

Sb $K\alpha_1$ λ = **469.372 X.U.**
Ag $K\alpha_1$ λ = **558.252 X.U.**

The value determined by Ingelstam is

Sb $K\alpha_1$ λ = 469.374 X.U.

and the average value computed by him from 5 different measurements is

Ag $K\alpha_1$ λ = 558.241 X.U. (7)

The determination of the absorption edge was carried out with a quartz crystal, having the atomic plane $13\bar{4}0$ perpendicular to the surface. The crystal was bent to a radius of 1022 mm. The time of exposure was 4 hours to get the edge and 2 hours to get the reference lines. The thickness of the absorbing layer was in one case 37 μ (plate 5) and in the other cases 24 μ (plates 9 and 11). The mean temperatures during the exposure of the edge and the reference lines respectively did not differ more than $0^\circ.5$ C. Thus no temperature correction has been introduced. The angular distance from the edge to the reference lines was computed from photometric curves and comparator readings.

The lattice constant is

1177.63 X.U. (8)

The wavelengths of the reference lines are

Te $K\alpha_1$ λ = 450.353 X.U.
Te $K\alpha_2$ λ = 454.832 X.U.
Te $K\beta_1$ λ = 399.166 X.U.

The results are as follows.

Table 2

Notations: $\Delta\varphi$ = the angle computed from the photometric curve and the comparator readings; φ_{18} = the glancing angle of the absorption edge at 18° C; λ = the wavelength of the absorption edge.

Plate No.	Reference line	$\Delta\varphi$	φ_{18}	λ X.U.
5	Te $K\alpha_1$ 1-order	$-1^\circ\ 6'\ 3''.2$	$9^\circ 55' 21''.4$	405.853
	α_2	$-1^\circ 12' 42''.8$	$21''.5$	405.854
	β_1	$9' 55''.7$	$22''.7$	405.868
9	α_1	$-1^\circ\ 5' 58''.2$	$26''.4$	405.910
	α_2	$-1^\circ 12' 38''.0$	$26''.3$	405.909
	β_1	$10'\ 3''.6$	$30''.6$	405.957
11	α_1	$-1^\circ\ 6'\ 3''.1$	$21''.5$	405.854
	α_2	$-1^\circ 12' 42''.0$	$22''.3$	405.863
			Mean value	405.884

The error of the mean value will not exceed 0.08 X.U. Thus, with the above values of the reference lines, the final result is

405.88 ± 0.08 X.U.

The width of the edge, evaluated from the photometer curve is 0.5 ± 0.1 X.U. Earlier results obtained by LEIDE and ROSS are

LEIDE 1925 (9)	406.09 ± 0.2 X.U.
ROSS 1933 (10)	405.81 ± 0.02 X.U.
Present result	405.88 ± 0.08 X.U.

I would like to thank Professor AXEL E. LINDH, Director of the Institute of Physics, for his kindness to provide me with all the necessary equipment and I am most indebted to Laborator ARNE ELD SANDSTRÖM for his instructive and valuable advice.

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Tryckt den 23 april 1951

Uppsala 1951. Almqvist & Wiksells Boktryckeri AB